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Using Smart Packaging in Fish and Fish Based Product

Akıllı Ambalaj Teknolojisinin Su Ürünlerinde Uygulanması

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ABSTRACT

Food packaging have three main roles during protection, preservation and storage are still involved better continuance of food quality. Evolution of civilization and improvement of new kind of foodstuffs, packaging industry must create new possibilities for preventation of food quality during shelf-life. The quality and safety of perishable food is related to microbial quality has got a significance role. Fish is a very perishable food product. It is a very low acidic food and thus is very liable to the expansion of food poisoning bacteria. Also decomposition of fish can be by reason of enzymatic spoilage, oxidation and/or bacterial spoilage. Fish is an important resource of polyunsaturated fatty acids stated to have defensive effects in opposition to heart-connected diseases. Some smart packaging mechanisms liable to determine this break down incident thought storage. In this review, smart packaging technologies that could be used to detect breakdown compounds from packed fish and fish products.

Keywords: Smart packaging, fish, Storage, Quality

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ÖZET

Gıda ambalajlarının gıda kalitesinin korunmasında önleyici, koruyucu ve depolama süresinde kalitenin korunması gibi üç temel görevi vardır. Globalleşmenin artması ve yeni türlerde gıda maddelerinin gelişmesiyle birlikte, ambalaj endüstrisi gıda kalitesinin depolama süresi boyunca korunması için yeni uygulamalar araştırılmaktadır. Bozulmaya karşı hassas gıdalarda kalitenin korunmasında mikrobiyal kalite son derece önemli yer tutmaktadır. Balık eti bozulmaya karşı hassas gıdalar arasındadır. Düşük aside sahip bir gıda olması sebebiyle gıda zehirlenmelerine neden olan bakterilerin oluşumuna imkan sağlayacak gıdalar arasında yer almaktadır. Ayrıca balık ürünlerinin bozulması, enzimatik yıkım, oksidasyon ve/veya bakteriyel bozulma nedeniyle gerçekleşebilmektedir. Su ürünleri çoklu doymamış yağ asitleri kaynağı olması sebebiyle kardiyovasküler hastalıklara karşı etkili olabilmektedir. Bazı akıllı ambalaj uygulamaları su ürünlerinin depolanması sırasında meydana gelen bozulmalara karşı duyarlıdır ve belirlenmesinde görev almaktadır. Bu derlemede, akıllı ambalaj teknolojisinin su ürünleri sektöründe uygulama olanaklarını incelenmiştir.

Anahtar sözcükler: Akıllı paketleme, Su ürünleri, Depolama, Kalite

1. INTRODUCTION

Smart Packaging

Usual food packaging is supposed for defendion, communication, applience and containment (Paine, 1991; Robertson, 2006). The package is used to defend the product from the deteriorative effects of environmental factors like light, heat presence or absence of humidity, microorganisms, pressure and etc. The main safety purpose for traditional packaging items which comes in connection with food is to be motionless as possible. Smart packaging that include active and intelligent packaging systems, are based on the functional contact between packaging environment and food. Increased understanding of health and environmental consumer definitely contributed to the growing necessity for used food packaging. Novel food packaging applications are developing as a response to consumer requires and industrial production tendency towards gently preserved, fresh, tasty and appropriate food products with extended shelf-life and controlled quality parameters. In addition, variations in trading and consumers demands are present main challenges to the food packaging industry and perform as precursor for the development of innovative packaging thought that prolong shelf-life while keeping up and checking food safety and quality (Dainelli et al., 2008; Bilska 2011). Yam et al. (2005) explain a package is “smart” if it has the capability to trail the product, substance the nature in or out the package, and connect with the customer. For instance, an intelligent package is individual that can control the quality and safety of a food and give early caution to the customer or food producer. Intelligent packaging consigns to a package that can significance environmental variations. (Summers, 1992). Other researcher described smart packaging as having two groups: basic smart packaging (Summers, 1992) and interactional or receptive smart packaging (Rodrigues and Han, 2003).

New concepts of active and smart packaging are due to play an increasingly significant role by offering numerous and innovative solutions for extending the shelf-life or maintain, improve or ensure food quality and safety (Gontard, 2006). Therefore, there is an exceptional interest among the food industry, trader, customer, and their related parties in developing a way that is easy, cheap, rapid, trusty and non-destructive to asses real-time freshness of food products (Kuswandi et al., 2012). An alternative application to attend to this necessity is the improvement of smart packaging in the form of a food spoilage indicator to observe freshness of products (Potyrailo et al., 2012).

For this purpose, various others concepts such as time/temperature and oxygen indicators ethanol emitters which was used for bakery products, ethylene absorbers (e.g. for climacteric fruits), carbon dioxide emitters/ absorbers, have been developed. Smart packaging is an up-coming technology that uses the interaction action of the package to promote judgment with purpose of provides the benefits of improved food safety and quality. Smart packaging is described as a structure that monitors the situation of packaged food to give information about the quality throughout storage, transport and marketing. (Yam et. al., 2005). The possibility of smart packaging technology is, ranging from food safety monitoring to reach the consumer. (Butler, 2004).

Principle of Smart Packaging

In packaging industry, "smartness" can have lot of explanations, and obscures some usefullies, based on the product being packaged – food, pharmaceutical, beverage and home product Examples of current and future functions that are considered to have "smartness" would be packages that: by prevent foods spoilage actively and extend shelf life of products, improve product look, aroma, taste characteristic. React dynamically to changes in product and/or in the package surroundings, for consumer give connect about product information, product history and other conditions (Han et al., 2005).

In smart packaging applications, indicators are described smart or interactive because they interrelate with components in the food. The smart packaging concentrate on sense and report the position of a product in term of its safety and quality Consumers increasingly need to know food security promise, particularly for perishable food products as fish. In the future, microbial augmentation and time–temperature optical indicators (TTIs) rooted on chemical, physical and/or enzymatic activity in the food products will provide an obvious, truthful and unmistakable suggestion of quality, protection and storage condition.

In this review, the importance of the application of smart packaging methods that provide communications between consumer and product, for fish and fish based products are described.

2. SMART PACKAGING IN FISH INDUSTRY

Fish is a highly vulnerable food which freshness and quality rapidly refuse post-mortem. Damage of freshness and spoilage of fish are complex processes, and several factors such as species and storage situations the spoilage pattern. For many years, the development of dependable methods to measure fish freshness and to determine quality parameter has been the aim of fish research (Di Natale et al., 2001; Gil et al., 2008). The present methods used in the food industry to control fish shelf life are founded on physical, chemical, microbiological and sensory parameters

(Ólafsdóttir et al., 2004). While, some of these methods are expensive, prolonged and need skilled personnel as an alternative, the development of rapid, cheap and easy quality control techniques, which can be applied at any period of the supply chain, is of much significance (Pons-Sánchez-Cascado et al., 2006). A possible resolution to this matter is to invent smart or intelligent packaging able to giving information about quality of fish and seafood products.

There are three types of indicators about smart packaging as external indicators, which are appended external the package, and contain time temperature indicators and physical disturb indicators. Secondly internal indicators, which are located inside the package-located in the headspace of the package or close to the lid as microbial indicators and oxygen leak indicators (Ahvenainen, 2003). Lastly, indicators that using special bar codes that stored food knowledge as use, consume during marketing (Coles et al., 2003).

2.1. Sensors

A sensor can be defined as a device used to find, place or measure energy or trouble provide a signal for the finding or dimension of a physical or chemical characteristic to which the equipment responds (Kress-Rogers, 1998; Kerry et al., 2006). Sensors give permanent output of indicator. Most of sensors include two major functional section, a transducer and a receptor.

2.1.1. Biosensor

Biosensors are generally worked to find, pick up and spread information pertaining to biological response (Yam et al., 2005). Biosensors include two parts as bio-receptors and transducers (Alocilja and Radke, 2003). The bio-receptor realize the goal analyze and the other part, transducer changes biochemical signals addicted on experimental electronic reaction (Yam et al., 2005). Transducers may be of visual, aural or electro-chemical. The bio-receptors may be both raw and natural materials like nucleic acid, enzyme, antigen, hormone, microorganisms.

Some researchers developed a biosensor for the detection of biogenic amines created owing to the by amination and transamination of aldehydes-ketones caused by microbial achievement or decarboxylation of amino acids. Pospiskova et al. (2013). This biosensor may useful for fish and fish-based products. The other biosensor that used in animal tissue for the finding of xanthine, as oxidation product was developed by Arvanitoyannis and Stratakos (2012) by check of xanthine oxide on the electrodes prepared of materials such as silver, platinum and pencil graphite (Devi et al., 2013; Dolmaci et al., 2012; Realini and Marcos, 2014).

Opto-chemical sensors are worked to detect the property of food products by impressioning gas analyte as volatile amines, hydrogen sulphide and carbon dioxide (Wolfbeis and List, 1995). The opto-chemical sensing process are of three types taking in fluorescence based structure with a pH susceptible pointer, absorption based colourimetric sensing and energy transport attitude using phase fluorimetric recongnition (Neurater et al., 1999; Mills et al., 1992). pH sensitive stains can be used to improve sensors for the finding of basic volatile amines in fish, meat and poultry. Using for this purpose using indicators based on methyl red/cellulose membrane, curcumin/bacterial cellulose membrane react during observable colourimetric variations to volatile amines relief during fish spoilage (Kuswandi et al., 2012, 2014). Ocular oxygen sensors are been explained by Papkovsky et al. (2002). Such systems are based on the theory of luminescence slaking or absorbance changes due to direct communication with the analyte.

Gas sensors are used for finding the existence of gaseous analyte in the package. It contains carbon dioxide sensors, oxygen sensors, water steam sensor, ethanol sensor, metal oxide semi-conductor ground effect transistors, organic handling polymers and piezoelectric crystal sensors (Kress-Rogers 1998, Kerry et al. 2006).

2.1.2. Chemical sensor

The chemical sensor or the receptor is a chemical sensitive covering ability of finding the incidence/ absence activity, structure, levels of specific chemical or gas through plane adsorption. Occurrence of specific chemicals are being monitored and changed into signals by transducer. Transducers are of both active and passive based on the exterior power necessity for controlling (Vanderroost et al., 2014). Nano- based sensors can be used to find chemical contaminants, product tampering, pathogens, spoilage, or track components during the processing chain (Nachay, 2007; De-Azeredo, 2009; Liu et al., 2007). Current develop in sensors are the use of visual transducers which do not require the electrical power and it can be state formally from an expanse by using visible or light. (Yebo et al., 2012).

2.1.3. Electronic nose

Electronic nose structure used to imitate the mammalian olfactory system within in a mechanism created to acquire repeatable dimension consenting to identification and categorization of aroma combination existing in the odour. It creates a single reply to each flavour or smell. Nose system include of a collection of both chemical and biosensors with limited specificity and statistical technique allowing the detection of simple of complex (Gardner and Bartlett, 1993; Vanderroost et al., 2014). Some researches using electronic nose structure to be successful in the quality assessment of fresh yellowfin tuna and vacuum packed beef (Blixt and Borch, 1999; Dobrucka and Cierpiszewski, 2014). Gomez et al. (2006) studied e-nose that determine the volatile compounds produced during tomato storage. Rajamaki et al. (2004) researched the quality of modified atmosphere packed broiler chicken cuts using electronic nose. The electronic nose results were compared with those obtained by the instrumental head space gas composition, microbiological analysis and sensory analysis. The e-nose could obviously different the chicken packages with decline from fresh packages.

2.2. Indicators

A part of smart packaging, fish freshness-meter is a system (or material) which general uses metabolites as “information” to monitor the position of fish freshness that can be completely related to fish spoilage. Currently, published work about fish freshness or fish spoilage indicators is limited even. Some publications have constructed indicators for the volatile compounds produced in microbial spoilage. For example, some researchers progressed a colorimetric dye-based sensor and marker for determining fish spoilage on the basis of the due to total volatile basic nitrogen (TVBN) by way of this on-package sensor envelops a pH responsive dye, bromocresol green, fall into a polymer medium (Byrne et al., 2002; Pacquit et al., 2006, 2007). General using of indicators which a part of smart packaging, is develop to the preservation of packaged fish and extending shelf life involves oxygen removal, temperature control, moisture control, addition of chemicals as natural acids, salt, sugar and carbon dioxide or a combination of these with useful packaging (Robertson, 2006; Restuccia et al., 2010).

Using pH dye, it responses to the pH change is affected by temperature, mainly when it is used in a frozen stat. As such there is a need to explore alternative methods for detection of fish freshness using indicator/sensor that is free from leaching, accurate, simple, low-cost, rapid, reliable, consumer friendly and non-invasive to evaluate the real-time fish freshness. One way to meet this requirement is that of the improvement of an easy freshness colour indicator in the form of packaged sensor marks that determine spoilage in fish and seafood. Volatiles amines as ammonia (NH3), trimethylamine (TMA) and dimethylamine (DMA) give to a quantity known as total volatile basic nitrogen (TVB-N) and are the typical matter prone for the fishy odour and flavour (EU Directive 95/149/EEC). There are some main indicators using in smart packaged fish and fish-based products.

2.2.1. Time–temperature indicators

The temperature changes occur in a food can cause changes in product quality and safety. The time temperature integrator or indicator (TTI) can be described as an easy, cheap way that can demonstrate an easily quantifiable, based on time-temperature change that indicate the full or incomplete temperature record of a food product to which it is attached (Taoukis and Labuza, 1989).

The principle of TTI process is an unalterable mechanical, microbiological chemical or enzymatic change, usually articulated as an obvious reply in the way of a mechanical distortion, colour improvement or colour transfer (Taoukis, 2008). TTIs may be categorized as both incomplete and full history indicators, based on their reaction mechanism as Critical temperature indicators (CTI) show communication over or under a reference temperature. Time temperature integrators or indicators (TTI) give a permanent, temperature dependent reply during the product's past. Likely fish, having high protein rate denaturation is an important parameter and containing above the critical temperature or expansion of a pathogenic microorganism is other important cases where a CTI would be useful. Critical temperature/time integrators (CTTI) are practical in suggesting failure in the circulation chain and for products in which response, important to quality or security, are began or happen at quantifiable rates over a critical temperature. For instance, such reactions are microbial growth or enzymatic activity that is inhibited below the critical temperature. The response rate and temperature dependence is controlled by the tag configuration, the diff using polymer's concentration and its glass transition temperature and can be set at the desirable range (Ahvenainen and Hurme, 1997; Taoukis, 2008; Selman, 1995; Taoukis and Labuza, 2003)

For chemical or physical response, it is based on chemical reaction or physical change towards time and temperature, such as acid–base reaction, melting, polymerization, etc. While for biological response, it is based on the change in biological activity, such as microorganism, spores or enzymes towards time or temperature (Otles, Yalcin, 2008; Kuswandiet al., 2011). The rate of change is temperature dependent, increasing at higher temperatures similarly to the deteriorative reactions responsible for product quality deterioration.

2.2.2. Freshness Indicators

Escaping indicator to package ensures package reliability during the production and marketing chain. Ocular oxygen indicators in MAP foods with low first oxygen are researched by Davies and Gardner (1996); Mattila-Sandholmand et al. (1995). Ocular oxygen indicators by means of redox dyes vary its colour with changes in oxygen level. Oxygen breaks through outflow may also be expend by the natural microorganism present in the food (Mattila-Sandholmand et al., 1998). A commercial oxygen indicator tablets which suggest the occurrence or nonappearance of oxygen by colour change. It implies the lack of oxygen (<0.01 %) by turning pink. At oxygen intensity of 0.5 % or further, the tablet turns blue. The occurrence of oxygen will be showed in a few minutes (Mitsubishi Gas Chemical 2014). The other commercial product has revealed reversible and non-reversible oxygen indicator brands for the optical suggestion of pack reliability (EMKO packaging, 2013).

2.3. Data Carriers

Data carrier, also recognized as mechanical detection devices, give information during food trade chain more efficient, to the advantage of food quality and protection (McFarlane and Sheffi, 2003). Furthermore, data carriers are more often locate on to tertiary packaging as multi-box containers, shipping, pallets, large packages. The most significant data carrier mechanism in the food packaging industry are barcode labels and RFID marks, which owned by the main group of expediency-enhancing intelligent systems (Robertson, 2012).

2.3.1. Barcodes

Because of their low cost and easily using, barcodes have been progressively used in the important trade and save to possible record control, stock rearrangement, and inspect (Manthou and Vlachopoulou, 2001). A barcode is a prototype of parallel areas and bars set up to represent 12 digits of data. The encoded information is read by an optical barcode scanner that sends the information to a system where it is stored and processed (Han, 2013). Reduced Space Symbology (RSS) barcodes were cultivated sequentially to encode more data in a smaller space.

2.3.2. Radio-frequency identification systems

An RFID structure contains three major components: a label formed by a microchip attached to a tiny antenna; a reader that emits radio indicator and receives answers from the label in return; (Kumar et al., 2009; Sarac et al., 2010). While RFID technology was well known extensively, the market diffusion has lagged following barcodes, cause of high cost (Preradovic and Karmakar, 2012). However, RFID technology should not be considered as a replacement for barcodes. Current applications of RFID tags, have different applications in the food industry, such as product classification and suggestionability (Hwang et al., 2015), cold chain observing (Badia-Melis et al., 2015), livestock administration (Ariff et al., 2014), and forecast shelf life of food product (Uysal et al., 2011). Using RFID technology for determine shelf life of fish and fish based product will significant invention in future.

3. CONCLUSION AND FUTURE DEVELOPMENTS

Changes in consumer favourites have cause to advances and improvements in novel packaging technologies. Smart packaging is useful for giving product information about quality during shelf life of treated or un-treated food products. Generally using sensors, biosensors, indicators as time-temperature and integrity, most preferable mechanisms. Use of time temperatures indicators can facilitate optimize product allocation, improve shelf life quality, monitoring and administration of food and thus decrease product waste from foodstuffs. With the aim of forward the attendance difference between potential and awareness of smart packaging applications is not well-known. Further modelling of the communications between foods and microorganisms under storage conditions. The potential advantages of smart packaging for muscle-based foods are changed. Imagining smart packaging can effectively supply solutions to current producer and costumer necessity, it emerges likely that smart packaging structure for muscle-based food as fish and fish based product will become more commercially feasible and common-place in future.

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